Switching to biofuels could place unsustainable demands on water use

Transition away from fossil fuels is underway, but without assessing demands on land and water resources we put the future health of our planet at risk

Arjen Y. Hoekstra

Arjen Hoekstra is professor of water management at the University of Twente, the Netherlands

Thursday 28 May 2015 12.07 BST

Decarbonising our economy must go hand in hand with lowering our water footprint. Photograph: © Cultura Creative (RF)/Alamy

As the world moves towards renewable sources of energy, it faces an accompanying challenge: water scarcity. The intensive water use in the coal, oil, gas and nuclear industries is well-documented, but if we want to encourage a faster transition to renewables we must also contemplate the water use of the alternatives

It is a great challenge to limit the drain on land and water resources now the transition has taken off. Bioenergy, hydropower, and wind, solar and geothermal energy all require substantial amounts of land and water resources. Given limitations to the availability of land and water, what energy scenarios are feasible in the long run?

With fossil fuels we have learned to worry about energy scarcity as a major concern for economic development and national security. In contrast, renewable energy seems inexhaustible: incoming solar radiation, for example, is far beyond what we need. The fact that renewable energy is available into infinity reinforces this idea of limitlessness. This, however, is a misunderstanding: we will replace energy scarcity by land and water scarcity.

Biofuels

Bioenergy production in particular requires vast amounts of land and water. Besides, with current energy-intensive agricultural practices, net energy output is far lower than gross energy production, sometimes even near zero. If only 10% of fossil fuels in the global transport sector were replaced by bioethanol from relatively efficient crops, global water demand would increase by 6-7%.

The production of biofuels at the rate we are used to consuming fossil fuels will require more land and water than sustainably available. Already today we have land and water footprints beyond maximum sustainable levels and bioenergy increasingly competing with food.

Hydropower and the dam debate

Hydropower, accounting for 16% of the world's electricity supply, is regarded as a clean form of energy. However, we cannot simply increase hydroelectric capacity. Dams can heavily impact on riparian ecosystems and societies, and any further damming of rivers should be subject to careful consideration.

Building new dams and reservoirs is often difficult because the required land is generally already in use for other purposes. For the Three Gorges Dam in China, over one million people were displaced. Besides, hydropower can be a large water consumer because of the additional evaporation from the reservoir created, which affects downstream water availability for other purposes. Damming rivers has therefore become a contentious topic.

Solar, wind and geothermal energy

Per unit of energy, the water footprint of bioenergy and hydroelectricity is two to three orders of magnitude larger than that of fossil fuels and nuclear. The water footprint of photovoltaic (PV) and wind energy is one to two orders of magnitude smaller.

Electricity from concentrated solar power has a similar water footprint to fossil fuels, while geothermal can be an order of magnitude smaller or even less. From a water consumption and scarcity perspective, it matters greatly whether we shift from fossil energy to bio and hydro or to solar, wind and geothermal energy.

All existing “green” energy scenarios, called “green” because of their considerable fractions of renewable energy, are based on considerable growth of bio and hydro in the mix, which means that the water footprint of the energy sector will grow sky-high if we follow such scenarios. True green scenarios, with a declining rather than increasing water footprint, must be primarily based on solar, wind and geothermal energy.

The transition to electricity

Solar energy is more efficient than biomass from a land use perspective because PV panels and concentrated solar power systems are more efficient at capturing incoming solar radiation than photosynthesis, thus generating more energy per square metre.

Photosynthesis, however, has the advantage that it results in storable bioenergy and can be turned into energy-dense biofuels, while PV results in non-storable electricity. Concentrated solar power systems can store energy by use of thermal energy storage, but the final product will still be electricity, not fuel.

Since substantial growth of bioenergy – beyond using rest streams of organic material – is impossible, our economies need to be further electrified: electric transport, but also electric heating, at least where surplus heat from industrial processes or geothermal energy doesn’t offer a solution. We need to find ways to store energy and design electrical grids that can handle the large variability of both electricity demand and supply.

Solar and wind power and earth’s heat offer possibilities to achieve energy self-sufficiency at much smaller scales than we are used to in our globalised fossil fuel economy. The time is ripe for a transition away from fossil fuels. Let’s be smart enough to invest in real sustainable solutions, which excludes biofuels that have been so much at the centre of attention in government policies. Decarbonising our economy can be combined with lowering our water footprint, let’s go for that choice.

The water hub is funded by Grundfos. All content is editorially independent except for pieces labelled “brought to you by”.